initiate operation of the automatic controller or computer MTC shown in FIG. 3' as controlling the operation of the tool 16-1 by predeterminately controlling the motors operating said tool and the tool then performs preprogrammed operations on the work piece W-1. In one form of this operation, the work may be moving at constant speed on conveyor 75 while the signals controlling the operation of the tool 16-1 are so composed as to move the tool along with the moving work and cause it to exercise said preprogrammed operations while the tool is moving to account for the movement of the work. In a second mode of operation, the detection signal is also operative to stop the conveyor 75 or the remotely located command signal generator or controller is programmed, not only to effect predetermined operation of the tool but also stoppage of the conveyor 75 so that the work W-1 may be operated on by the tool while said work is stationary on the conveyor.

In the third mode of operation, a work piece W-2, which is self-supported or supported by a carrier or pallet WP on the conveyor 75, is transmitted to a temporary work station 76-2 by means of a transfer device 72-2 located adjacent the work station and operative to push or otherwise carry the work into the temporary work station platform. The automatically controlled machine tool 16-2 is either prepositioned at the work station 76-2 as a result of its previous movement thereto or is driven to the work station under the control of signals generated by a computer or controlled command message generator of the type illustrated in FIG. 3. Alignment of the tool 16-2 with respect to the work W-2 may be effected by scanning alternate switch means detecting a marker or other suitable locating means at the work station 76-2 or by detecting the work itself or its supporting pallet. When the preprogrammed operations are completed by the machine 16-2 on the work W-2, said machine or another machine such as an automatic manipulator, which is drivable along either track 22-1 or track 22-2, is

operated by the same computer and is operative to lift or otherwise transfer the work to the conveyor 75 for movement to the next station.

A fourth mode of operation of the apparatus of FIG. 6 involves the automatic control of a plurality of machines or tools, four of which are illustrated and denoted by notations 16-3, 16-4, 16-5 and 16-9 and all of which are remotely controlled, as described, to perform different operations on the same work piece W-3. The work piece W-3 may comprise a large unit of work such as a casting requiring multiple operations thereon which may be simultaneously performed or may comprise an assembly of elements forming a product or a product subassembly. The tools 16-3 to 16-6 may comprise one or more power-operated devices for performing such operations as drilling, tapping, assembling screws or other fasteners, welding, spraying, assembling parts or sub-assemblies with the work W-3, inspecting, plating, spraying, deburring, etc. Said tools may perform such preprogrammed operations from either or both sides of the conveyor 75, as certain of the tools are operative to move along and be positioned with respect to the track 22-2, while others operate on track 22-1 from the other side of the work W-3. Here again, the multiple tools may be programmed to operate on the work W-3 while said work is stationary on the conveyor 75 or adjacent thereto or while said work is in motion with the tools performing their operations while accounting for the work movement by relatively moving along the guide ways 22-1 and 22-2 with the work.

The work stations 76 may contain auxiliary means for manipulating the work with respect to the tool to present different portions of the work to the tool head or automatically controlled manipulators forming some of the tools 16 may be operative along the track ways 22-1 and 22-2 to seize and vary the attitude of the work or hold same during the operation of one or more tools located on the same or opposite track way to perform preprogrammed operations on the work.

If the conveyor 75 is controlled by a computer which also controls the operations of the various tools and the loading of units of work onto said conveyor, then the location of any particular unit of work on the conveyor will be a known factor during any interval in a work cycle and, accordingly, the proper distribution of command control messages to the different machine tools may be effected by properly timing the entire operation and operating the remote computer or message generator by sequentially reproducing, generating and transmitting the desired command control messages at predetermined time intervals to control the respective machine tools as described.

FIG. 7 illustrates a modified form of automatic production system 74 embodying, in addition to the features found in FIG. 6, the provision of a bridge crane assembly 78, which is supported for movement above and parallel to the conveyor 75 and contains one or more carriages, one of which is shown, at numeral 80, adapted with tooling and/or work handling means for performing operations on work carried by said conveyor 75. The crane apparatus 78 may be used to perform a number of functions including, in addition to supporting and positioning power-operated tooling such as power-operated drills, riveters, inspection devices, and other tooling below the carriage 80 thereof to locate said tooling above the work for operating on the top wall and upper portion of the work, such other functions as picking up the work and transferring it to a fixture or platform adjacent the conveyor 75 or to another conveyor, turning said work around or assembling it with other work, feeding parts or subassemblies to the work or holding and repositioning the work with respect to other tooling such as the track travelling tools 16-1 and 16-6 illustrated. The crane and tooling or handling manipulator of assembly 78 may be operated in an automatic mode under the control of the master controller or computer controlling operation of the other tooling and/or may be controlled by preprogrammed means located on the bridge crane when a detection

means 81 located on the bridge 79 of the crane 78 or on the structure depending downwardly from the carriage 80 scans and detects work travelling along the conveyor 75.

In a particular form of the apparatus shown in FIG. 7, it is noted that one or more bridge cranes such as 78 for supporting tooling and/or manipulation means for performing on work along the production line and a plurality of the described track travelling tools 16 of the type described may all be operative to travel and be supported by the same bi-rail trackways denoted 22-3 and 22-4 in FIG. 7, and the cranes 78 may be so mounted as to permit said cranes to bypass the tools 16 to operate along any selected length of the production line.

FIG. 8 illustrates details of a portion of the overhead conveying apparatus of FIG. 7, including one of the trackways 22-3, production tool 16-6 suspended therefrom and bridge crane 78 movable therealong. The trackway 22-3 comprises an overhead supported I-beam 82, the lower flange 83 of which is adapted to support and guide the wheels 85 of the carriage 86 of the tool 16-6, which tool may embody the features shown in FIGS. 2, 2' and 2" or modifications thereof. Secured to the upper flange 84 of the I-beam is a rail 86 having a V-shaped channel in its upper surface. Riding in the V-shaped channel in 86 and guided thereby are the wheels 81 of the bridge crane 78. The rail 86 may also comprise an integral portion of the I-beam or may be replaced by a groove or V-shaped channel in the upper flange thereof. A similar rail or channel formation in the other trackway 22-4 may serve to support and guide the wheels supported by the other end of the bridge crane 78 so that a single pair of I-beams may define the trackways 22-3 and 22-4 and support both the monorail travelling tools 16 and one or more bi-rail devices 78 or bridge cranes defining the automatic production system or line 74'. It is noted that the bridge crane 78, if suspended as in FIG. 8, and if the carriage or tool assembly 80 suspended therefrom is centered on the cross-track 79